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(54) OPTICAL ELEMENT AND METHOD FOR MANUFACTURING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an optical element which reversibly controls the degree and presence of reflection with application of an electric field, is manufactured in a usual bright room where light in the visible region is present, further has high reflectance and has uniform reflectance in a display screen and a method for manufacturing the same.

SOLUTION: In the optical element consisting of a polymerized substance of a polymerizable composition containing (A) a liquid crystal material and (B) a polymerizable compound existing between two transparent substrates with electrode layers,

forming multilayer structure of the liquid crystal

material and the hardened polymerized substance of

the polymerizable composition which are alternately repeated, further making contents of

the liquid crystal material and the hardened polymerized substance in the formed layers

different corresponding to the respective layers and having a refractive index periodically

varying, when the polymerizable composition is polymerized by irradiation with light in an

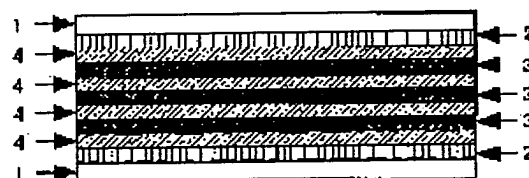
ultraviolet ray region, the optical element and the method for manufacturing the same

exhibit ≤ 40 W/m² sum of intensity of reflected light of light transmitted by the

polymerizable composition on a boundary between the polymerizable composition and the

transparent electrode and that of reflected light on a boundary between the transparent

electrode and the transparent substrate.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] The polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, and (B) polymerization nature compound consists of that by which the polymerization was carried out. In the optical element from which the content of the liquid crystal ingredient of a layer with which the liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent took the multilayer structure repeated by turns, and were formed, and a polymerization hardened material changes with layers, and a refractive index changes periodically The optical element whose sum of the reinforcement of the reflected light in the polymerization nature constituent of light, the reinforcement of the reflected light in a transparency inter-electrode interface and the transparency electrode which penetrated the polymerization nature constituent at the time of the polymerization of the polymerization nature constituent by the optical exposure of an ultraviolet-rays field, and the interface between transparency substrates is two or less 40 W/m.

[Claim 2] The optical element according to claim 1 whose polymerization nature constituent is a polymerization nature constituent which contains (C) photopolymerization initiator further.

[Claim 3] The optical element according to claim 1 or 2 whose thickness of a transparency electrode is 40-200nm.

[Claim 4] (A) The optical element of any one publication of claim 1-3 in which the liquid crystal ingredient contains the liquid crystal which has a cyano group at a tolan frame or the end.

[Claim 5] The optical element of any one publication of claim 1-4 whose optical element is a reflective mold optical element.

[Claim 6] The optical element of any one publication of claim 1-4 whose optical element is a transparency mold optical element.

[Claim 7] The optical element of any one publication of claim 1-6 which changed spacing of the layer which mainly consists of a liquid crystal ingredient, and the layer which mainly consists of a polymerization hardened material for every pixel electrode.

[Claim 8] The polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, and (B) polymerization nature compound consists of that by which the polymerization was carried out. In manufacture of the optical element from which the content of the liquid crystal ingredient of a layer with which the liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent took the multilayer structure repeated by turns, and were formed, and a polymerization hardened material changes with layers, and a refractive index changes periodically So that the sum of the reinforcement of the reflected light in the polymerization nature constituent of light, the reinforcement of the reflected light in a transparency inter-electrode interface and the transparency electrode which penetrated the polymerization nature constituent at the time of the polymerization of the polymerization nature constituent by the optical exposure of an ultraviolet-rays field, and the interface between transparency substrates may become two or less 40 W/m The manufacture approach of the optical element characterized by adjusting whenever [to the thickness of a polymerization nature constituent, a transparency electrode, and the refractive index of a transparency substrate, the wavelength of the light of the ultraviolet-rays field to irradiate and a transparency electrode, and the transparency cel of the light of an ultraviolet-rays field to irradiate /

incident angle].

[Claim 9] The manufacture approach of the optical element according to claim 8 which makes the sum of the reinforcement of the reflected light in the polymerization nature compound of the light after polymerization nature constituent transparency, the reinforcement of the reflected light in a transparency inter-electrode interface, a transparency electrode, and the interface between transparency substrates two or less 40 W/m by setting thickness of a transparency electrode to 40-200nm.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] By impressing electric field etc., this invention penetrates alternatively, reflects the light of the wavelength of ultraviolet, visible, and a near-infrared region, and relates to the optical element or optical display device which can use the light filter and liquid crystal display component which control a reflective degree reversibly further, a liquid crystal modulated light component, etc., and its manufacture approach.

[0002]

[Description of the Prior Art] What vapor-deposited thin films, such as a metal, on glass, and the thing which recorded the interference light on silver salt or a photosensitive ingredient as a display device using a hologram are conventionally known as the optical element which penetrates alternatively the light of the wavelength of ultraviolet, visible, and a near-infrared region, and may reflect it, and an optical display device, and it gets down, and is used for an infrared cut filter etc., and use is further considered by the HUD, a high mounting stop lamp, a solid three-dimensional display, etc.

[0003] However, transparency of specific wavelength and the reflective degree of what vapor-deposited thin films, such as a metal, on glass, the volume hologram optical element using a hologram, or a display device are always fixed, and what can control such reflective degrees and reflective existence reversibly is desired further.

[0004] On the other hand, an interference light is irradiated at the non-hardened material of a photoresist, and the mixture containing a liquid crystal ingredient, a photo-curing object is stiffened, it has the layer structure from which the refractive index by the liquid crystal ingredient and the hardened material changes periodically by turns, and the refractive index of a liquid crystal ingredient is changed by making electric field impress to this, and the optical element which can control a reflective degree and reflective existence reversibly is proposed (for example, JP,4-355424,A etc.).

[0005] However, since the light of a light field is conventionally used for these manufactures at the light source, sensitizing dye must be added and used for the non-hardened material of a photoresist, and the mixture containing a liquid crystal ingredient, coloring by sensitizing dye takes place, and there is a trouble that the color purity of the reflected light falls. Furthermore, in order that a polymerization may begin before irradiating an interference light if it works in the usual bright interior of a room where the light exists in order to carry out the polymerization of the non-hardened material of a photoresist using the light of the wavelength of a light field, it must work in a dark room etc. and workability has troubles, such as being bad.

[0006]

[Problem(s) to be Solved by the Invention] By impressing electric field, the technical problem which this invention tends to solve can control a reflective degree and reflective existence reversibly, and can be manufactured in the usual bright interior of a room where the light exists, and its reflection factor is high, and it is to offer the optical element with a uniform reflection factor and its manufacture approach in the screen.

[0007]

[Means for Solving the Problem] this invention persons came to solve this invention, as a result of

repeating research wholeheartedly. Namely, this invention consists of that to which the polymerization of the polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which have (1) electrode layer, and (B) polymerization nature compound was carried out. In the optical element from which the content of the liquid crystal ingredient of a layer with which the liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent took the multilayer structure repeated by turns, and were formed, and a polymerization hardened material changes with layers, and a refractive index changes periodically The polymerization nature constituent of light, the reinforcement of the reflected light in a transparency inter-electrode interface and the transparency electrode which penetrated the polymerization nature constituent at the time of the polymerization of the polymerization nature constituent by the optical exposure of an ultraviolet-rays field, the optical element whose sum of the reinforcement of the reflected light in the interface between transparency substrates is two or less 40 W/m, and [0008] (2) An optical element given in (1) whose a polymerization nature constituent is a polymerization nature constituent which contains (C) photopolymerization initiator further, and [0009] (3) An optical element given in (1) whose thickness of a transparency electrode is 40-200nm, or (2), and [0010] (4) The optical element of any one publication of above-mentioned (1) - (3) in which (A) liquid crystal ingredient contains the liquid crystal which has a cyano group at a tolan frame or the end, and [0011] (5) The optical element of any one publication of (1) - (4) whose optical element is a reflective mold optical element, and [0012] (6) The optical element of any one publication of (1) - (4) whose optical element is a transparency mold optical element, and [0013] (7) The optical element of any one publication of (1) - (6) which changed spacing of the layer which mainly consists of a liquid crystal ingredient, and the layer which mainly consists of a polymerization hardened material for every pixel electrode, and [0014] (8) The polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, and (B) polymerization nature compound consists of that by which the polymerization was carried out. In manufacture of the optical element from which the content of the liquid crystal ingredient of a layer with which the liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent took the multilayer structure repeated by turns, and were formed, and a polymerization hardened material changes with layers, and a refractive index changes periodically So that the sum of the reinforcement of the reflected light in the polymerization nature constituent of light, the reinforcement of the reflected light in a transparency inter-electrode interface and the transparency electrode which penetrated the polymerization nature constituent at the time of the polymerization of the polymerization nature constituent by the optical exposure of an ultraviolet-rays field, and the interface between transparency substrates may become two or less 40 W/m The manufacture approach of the optical element characterized by adjusting whenever [to the thickness of a polymerization nature constituent, a transparency electrode, and the refractive index of a transparency substrate the wavelength of the light of the ultraviolet-rays field to irradiate and a transparency electrode, and the transparency cel of the light of an ultraviolet-rays field to irradiate / incident angle], and [0015] (9) Include the manufacture approach of the optical element a publication in (8) which makes the sum of the reinforcement of the reflected light in the polymerization nature compound of the light after polymerization nature constituent transparency, the reinforcement of the reflected light in a transparency inter-electrode interface, a transparency electrode, and the interface between transparency substrates two or less 40 W/m by setting thickness of a transparency electrode to 40-200nm.

[0016]

[Embodiment of the Invention] An example of the cross section of the optical element of the reflective mold manufactured by drawing 1 by this invention is shown. In drawing 1, 1 shows a transparency substrate, 2 shows a transparency electrode, 3 shows a layer with many contents of liquid crystal, and 4 shows a layer with many contents of a polymerization hardened material. Drawing 2 shows an example of the cross section of the optical element of the transparency mold manufactured by this invention. In drawing 2, 1 shows a transparency substrate, 2 shows a transparency electrode, 3 shows a layer with many contents of liquid crystal, and 4 shows a layer with many contents of a polymerization hardened material.

[0017] An example of the concrete manufacture approach of the optical element of the reflective mold of this invention is shown in drawing 3 . A cel is formed using two transparency substrates with an electrode, and the polymerization nature constituent containing a liquid crystal ingredient and a polymerization nature compound is made to intervene in the cel in drawing 3 . With a beam expander, the diameter of an optical axis is extended, coherent light, such as light of an ultraviolet-rays field, is dichotomized by the beam splitter in it, irradiate a polymerization nature constituent from a 2-way using a mirror etc., two light is made to interfere, an interference light is produced, and this interference light is irradiated.

[0018] As for the bright part of an interference light, the solubility of the liquid crystal ingredient of the bright part of an interference light decreases by that cause by the polymerization of the polymerization nature compound in a polymerization nature constituent advancing preferentially, and a liquid crystal ingredient is discharged from the bright part of an interference light, and forms a layer with many contents of a polymerization hardened material. On the other hand, the polymerization of a polymerization nature compound does not advance, but the liquid crystal ingredient discharged from the part with a still brighter interference light is added, and the dark part of an interference light forms a layer with many contents of a liquid crystal ingredient. The optical element in which the multilayer structure from which the refractive index of a layer with many contents of the liquid crystal ingredient of three in drawing 1 and a layer with many contents of the polymerization hardened material of 4 changed periodically by turns by this was formed can be obtained.

[0019] Drawing 4 is the enlarged drawing of 9 transparency cel of drawing 3 , and drawing 4 is the mimetic diagram showing the optical path of light when the reinforcement of the reflected light in the polymerization nature constituent and transparency inter-electrode interface of light after penetrating a polymerization nature constituent, and the reflected light in a transparency electrode and the interface between transparency substrates is low further. In drawing 4 , the laser light (light of an ultraviolet-rays field) of 12 penetrates the prism, 1 transparency substrate, and 2 transparency electrodes of 10, interferes with the laser light of 13 from another side of a transparency cel, and produces the interference fringe of 14.

[0020] The optical element in which the multilayer structure from which this interference light is irradiated at the polymerization nature constituent containing the liquid crystal ingredient and polymerization nature compound of 11 in a transparency cel, and the refractive index of a layer with many contents of a liquid crystal ingredient and a layer with many contents of a polymerization hardened material changes periodically by turns was formed can be obtained. In addition, the light 15 and 16 which was not used for the interference light among the laser light of 12 and 13 penetrates 2 transparency electrodes, 1 transparency substrate, and the prism of 10.

[0021] Drawing 5 is the enlarged drawing of 9 transparency cel of drawing 3 , and drawing 5 showed further the case where the reinforcement of the reflected light of the interface of the polymerization nature compound of the light after transparency of the polymerization nature compound by the wavelength and the incident angle of light of an ultraviolet-rays field at the time of the polymerization of a polymerization nature compound and a transparency electrode and the reinforcement of the reflected light of the interface of a transparency electrode and a transparency substrate were high.

[0022] In drawing 5 , the laser light of 12 penetrates the prism, 1 transparency substrate, and 2 transparency electrodes of 10, interferes with the laser light of 13 from another side of a transparency cel, and produces the interference fringe of 14. This interference light is irradiated at the liquid crystal ingredient of 11 in a transparency cel, and the mixture of a polymerization nature compound.

[0023] However, it reflects in 15, the thing penetrated through 2 transparency electrodes, 1 transparency substrate, and the prism of 10 to 16, and 17 and 18 with a transparency electrode or a transparency substrate, and the light which was not used for the interference light among the laser light of 12 and 13 has some which carry out incidence to the polymerization nature constituent of 11 again. For this reason, the interference light from which spacing of the light and darkness of an interference fringe differs arises in the various directions by the light of 12, 13, 17, and 18 grades in the polymerization nature constituent of 11.

[0024] When the reinforcement of the reflected light in the polymerization nature constituent and

transparency inter-electrode interface of light after penetrating a polymerization nature constituent, and the reinforcement of the reflected light in a transparency electrode and the interface between transparency substrates are high. Various layer structures are formed in addition to the multilayer structure from which the refractive index of a layer with many target liquid crystal ingredient contents and a layer with many contents of a polymerization hardened material changes periodically by turns. The reflection factor in the screen becomes uneven, and since the reflected lights other than the wavelength made into the purpose are formed while the reflection factor of the reflected light made into the purpose falls greatly, manufacture of a good optical element becomes difficult.

[0025] (A) The sum of the reflected light reinforcement in a liquid crystal ingredient, the polymerization nature constituent of the light of the ultraviolet-rays field which penetrated the polymerization nature constituent containing (B) polymerization nature compound, and a transparency inter-electrode interface, and the reflected light reinforcement in a transparency electrode and a transparency substrate interface. It is influenced by whenever [to the thickness of a polymerization nature constituent, a transparency electrode, and an each refractive index of a transparency substrate and a transparency electrode, the wavelength of the light of the ultraviolet-rays field to irradiate, and the transparency cel of the light of an ultraviolet-rays field to irradiate / incident angle].

[0026] As the sum of the reflected light reinforcement in the polymerization nature constituent and transparency inter-electrode interface of light of an ultraviolet-rays field which penetrated the polymerization nature constituent, and the reflected light reinforcement in a transparency electrode and a transparency substrate interface is low, it is more desirable. In order to reduce this reflected light, the approach of making in agreement the refractive index of a polymerization nature constituent, a transparency electrode, and a transparency substrate, the approach of controlling the thickness of a transparency electrode, etc. are mentioned.

[0027] However, the approach of making in agreement the refractive index of a polymerization nature constituent, a transparency electrode, and a transparency substrate. The refractive indexes of ITO (oxidization in JUUMU tin oxide) of a transparency electrode are 1.9-2.1. (A) The refractive indexes of the polymerization nature constituent containing a liquid crystal ingredient and (B) polymerization nature compound are usually 1.5-1.7, and since the refractive indexes of a transparency substrate are 1.4-1.6, generally it is difficult to make in agreement the refractive index of a polymerization nature constituent, a transparency electrode, and a transparency substrate.

[0028] Of course, it is useful to adjust whenever [to the wavelength of making in agreement the refractive index of a polymerization nature constituent, a transparency electrode, and a transparency substrate and the light of the ultraviolet-rays field to irradiate and the transparency cel of the light of an ultraviolet-rays field to irradiate / incident angle] proper as much as possible, when enlarging the reflection factor of the purpose reflected light, making small the sum of the reflected light reinforcement of the reflected lights other than the purpose wavelength and manufacturing a good optical element. It is desirable still more desirable that they are two or less 40 W/m, and the sum of the reflected light reinforcement in the polymerization nature constituent, the reflected light reinforcement in a transparency inter-electrode interface, transparency electrode, and transparency substrate interface of light of an ultraviolet-rays field which penetrated the polymerization nature constituent is two or less 20 W/m.

[0029] So that the sum of the reinforcement of the reflected light in the polymerization nature constituent of the light of an ultraviolet-rays field, the reflected light reinforcement in a transparency inter-electrode interface and the transparency electrode which penetrated the polymerization nature constituent at the time of the polymerization of the polymerization nature constituent by the optical exposure of an ultraviolet-rays field, and the interface between transparency substrates may become two or less 40 W/m. It is important to adjust whenever [to the thickness of a polymerization nature constituent, a transparency electrode, and the refractive index of a transparency substrate, the wavelength of the light of the ultraviolet-rays field to irradiate and a transparency electrode and the transparency cel of the light of an ultraviolet-rays field to irradiate / incident angle].

[0030] For example, the sum of the reflectivity in the polymerization nature constituent, the reflected light reinforcement in a transparency inter-electrode interface, transparency electrode, and transparency substrate interface of light of an ultraviolet-rays field which penetrated the

polymerization nature constituent can be found using the simulation software of Geomatec, Inc. by inputting whenever [thickness / of a polymerization nature constituent, a transparency electrode, and an each refractive index of a transparency substrate and a transparency electrode /, and incident angle / of exposure light]. Therefore, the thickness of a transparency electrode required in order that the sum of the reinforcement of the reflected light may make it two or less 40 W/m on each refractive index of a specific polymerization nature constituent, a transparency electrode, and a transparency substrate and the incident angle conditions of exposure light can be counted backward using this simulation software.

[0031] The thickness of a transparency electrode for the reflected light reinforcement in the polymerization nature constituent and transparency inter-electrode interface of light of an ultraviolet-rays field and the reflected light reinforcement in a transparency electrode and a transparency substrate interface to decrease Although it asks by whenever [to the refractive index of a polymerization nature constituent, a transparency electrode, and a transparency substrate, the wavelength of the light of the ultraviolet-rays field to irradiate, and the transparency cel of the light of an ultraviolet-rays field to irradiate / incident angle], 40-200nm is desirable and 60-170nm is usually more desirable.

[0032] To the transparent substrate which has an electrode layer, the multilayer structure repeated by turns [of the liquid crystal ingredient in this invention and a polymerization hardened material] may be parallel, and may incline at an angle of specification. To the transparent substrate side which has an electrode layer, when near in parallel, it becomes the optical element of a reflective mold, and the multilayer structure repeated by turns [of a liquid crystal ingredient and a polymerization hardened material] serves as an optical element of a transparency mold, when perpendicularly near.

[0033] In the case of the optical element of a reflective mold, only specific wavelength and the light of a wavelength region are reflected among the light which carried out incidence to the optical element, and most light in which others carried out incidence penetrates. In the case of the optical element of a transparency mold, the spectrum of the light which carried out incidence to the optical element is carried out, and it is penetrated and reflected.

[0034] A liquid crystal ingredient is covered with a polymer and the layer with many contents of the liquid crystal ingredient of three in drawing 1 and drawing 2 shows structure including the drop let condition which exists independently, or the structure which the liquid crystal ingredient opened for free passage. A liquid-crystal ingredient is covered with a polymer, the structure which exists independently in the state of drop let, or a liquid-crystal ingredient is covered with a polymer, and structure including the drop let condition which a liquid-crystal ingredient is covered with a polymer and exists independently expresses the structure where of the structure which exists independently in the state of drop let, and the structure where of a liquid crystal ingredient is open for free passage to some extent, and exists are intermingled.

[0035] A liquid crystal ingredient is covered with a polymer, and with the rate of polymerization of a polymerization nature compound, or the ratio of the liquid crystal ingredient in a constituent, the layer with many contents of the liquid crystal of 3 shows structure including the drop let condition which exists independently, or shows with them the structure which the liquid crystal ingredient opened for free passage. A liquid crystal ingredient is covered with a polymer, and the driver voltage of an optical element shows the inclination which becomes high, so that there are many rates of the drop let condition of a liquid crystal ingredient in the case of structure including the drop let condition which exists independently. Therefore, since structure with few drop let conditions of a liquid crystal ingredient becomes low [driver voltage], it is desirable.

[0036] The refractive index of a layer with many contents of a liquid crystal ingredient becomes higher than the refractive index of a layer with many contents of a polymerization hardened material. The light of specific wavelength is reflected among the light which the Bragg diffraction shown by the formula (1) produced, and carried out incidence to the optical element according to the difference of such two refractive indexes of the multilayer structure of a layer.

[0037] Formula (1)

$2d\sin\theta = n\lambda$ (among a formula, in d , the Bragg angle and λ express the wavelength of the reflected light, and, as for n , spacing of the center to center of a layer with many contents of a liquid crystal ingredient and a layer with many contents of a polymerization hardened material and

theta express a degree)

[0038] The wavelength of light reflected is determined by spacing of the center to center of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material with the Bragg's equation shown by the formula (1). If spacing of the center to center of a layer with many contents of the liquid crystal formed into an optical element and a layer with many contents of a polymerization hardened material is fixed to reflect only the light of specific wavelength, it will become possible to reflect only specific wavelength. Moreover, when reflecting the light of a certain wavelength region, the light of the wavelength region should just form the interlayer spacing of a layer with many contents of a liquid crystal ingredient, and a layer with many contents of a polymerization hardened material so that diffraction may be started.

[0039] If the reflection factor of the specific wavelength by the reflective mold optical element of this invention puts in another way the difference and the number of repeats of layer structures of the refractive index of a layer with many contents of a liquid crystal ingredient, and a layer with many contents of a polymerization hardened material, it will be determined by the thickness of the whole multilayer structure, and a reflection factor becomes large, so that the thickness of the whole multilayer structure is thick.

[0040] Moreover, since a reflection factor becomes high, it is so desirable that the difference of the refractive index of a layer with many contents of a liquid crystal ingredient and a layer with many contents of a polymerization hardened material is large to enlarge the difference of the refractive index of a layer with many contents of liquid crystal and a layer with many contents of a polymerization hardened material. Therefore, if it will be made thin if the thickness of the multilayer structure by the layer with many contents of a liquid crystal ingredient and the layer with many contents of a polymerization hardened material has the large difference of the refractive index, and the difference of a refractive index is small and it will thicken, the same reflection factor will be obtained.

[0041] However, driver voltage will become high, if the thickness of the whole multilayer structure is thick when changing a reflection factor reversibly with an electrical potential difference etc. Therefore, enlarged the difference of the refractive index of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material, and thickness was made thin, it is [direction] desirable and the thickness of the whole multilayer structure has desirable 2-50 micrometers.

[0042] In order to control a reflective degree and reflective existence reversibly, it becomes possible by impressing electric field, a field, etc. to a component, changing the refractive index of the liquid crystal in a component, and changing continuously the difference of the refractive index of a layer with many contents of the liquid crystal ingredient of 3 in drawing 1 or drawing 2 , and a layer with many contents of the polymerization hardened material of 4.

[0043] A liquid crystal ingredient carries out orientation of the time of electrical-potential-difference impression in the direction of electric field, and in order that the difference of the refractive index of a layer with many contents of a liquid crystal ingredient and the refractive index of a layer with many contents of a polymerization hardened material may decrease, a reflection factor decreases. By controlling the electrical potential difference to impress, it is possible to control the reflection factor of specific wavelength continuously.

[0044] In the case of the component of a reflective mold, it becomes possible by setting constant spacing of a layer with many contents of a liquid crystal ingredient, and a layer with many contents of a polymerization hardened material, and forming an electrode for every pixel to display a monochromatic alphabetic character and a monochromatic picture. Moreover, it becomes possible without using a color filter etc. by forming in spacing which produces the reflected light corresponding to three colors of RGB for a layer with many contents of a liquid crystal ingredient, and a layer with many contents of a polymerization hardened material for every pixel electrode to perform color display.

[0045] As an approach of forming in spacing which produces the reflected light corresponding to three colors of RGB for a layer with many contents of a liquid crystal ingredient, and a layer with many contents of a polymerization hardened material for every pixel electrode For example, a photopolymerization initiator is made to intervene a liquid crystal ingredient, a polymerization

nature compound, and if needed between two transparent substrates which have an electrode layer, a protection-from-light mask is formed in the part of two colors of green and blue among three colors of RGB, and the interference light used as the interlayer spacing which makes only a red part produce reflection of red is irradiated. Next, the protection-from-light mask of a green part is removed, and the interference light used as the interlayer spacing which produces green reflection is irradiated. Finally, the protection-from-light mask of a blue part is removed, and the interference light used as the interlayer spacing which produces blue reflection is irradiated.

[0046] Since the optical element of this invention consists of a liquid crystal ingredient and a polymerization hardened material compared with the volume hologram optical element by conventional resin, the refractive-index difference between layers can be enlarged and diffraction efficiency serves as a high optical element. Moreover, the manufacture approach of this invention does not need a special ingredient which is used for the usual volume hologram, and after hardening, since it is necessary to remove a specific ingredient or and it does not need to infiltrate other ingredients like the international public presentation No. 10926 [91 to], productivity is good [the approach].

[0047] The substrate used by this invention may be a strong ingredient, for example, glass etc., and may be the ingredient which has flexibility, for example, the thing like plastic film. Two substrates may separate suitable spacing face to face. Moreover, they have transparency and must carry out vision of the multilayer structure pinched between the two sheets from the external world. However, perfect transparency is not made indispensable.

[0048] According to the purpose, a transparent electrode may be arranged on that whole surface or a partial target at this substrate. Moreover, the active-matrix substrate which prepared active elements, such as a thin film transistor (TFT), a thin-film diode, and a metallic insulator metal nonlinear resistance component (MIM), for every pixel electrode may be used.

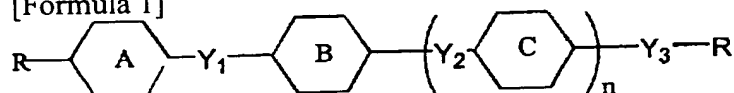
[0049] In order to control the thickness of the whole multilayer structure which consists of liquid crystal and a polymerization hardened material, the spacer for spacing may be made to usually intervene like a well-known liquid crystal device between two substrates. You may mix in the solution containing a liquid crystal ingredient and a polymerization hardened material, and a spacer may be applied on a substrate. As these spacers, the thing for various liquid crystal cells, such as a Mylar, an alumina, rod type glass fiber, a glass bead, and a polymer bead, can use it without a limit especially, for example.

[0050] Of course, it does not require that (A) liquid crystal ingredient used by this invention is a single liquid crystallinity compound. It aims at improving solubility with the property of a liquid crystal ingredient, i.e., the phase transition temperature of an isotropic liquid and liquid crystal, the melting point, viscosity, delta n and delta epsilon, a polymerization nature compound, etc. You may be two or more sorts of liquid crystal compounds, and the optical element after manufacture should just be the liquid crystal which can acquire a good property that what is necessary is just what can choose and blend suitably, can use and is usually recognized as a liquid crystal ingredient by this technical field.

[0051] As a (A) liquid crystal ingredient used by this invention, a nematic liquid crystal, a smectic liquid crystal, cholesteric liquid crystal, etc. are desirable, and especially a nematic liquid crystal is desirable. Moreover, in order to improve the engine performance, chiral compounds, such as cholesteric-liquid-crystal, chiral nematic liquid crystal, and chiral smectic liquid crystal, etc. may be contained.

[0052] (A) As a liquid crystal ingredient, they are the following general formulas [0053], such as a benzoate system, a cyclohexane-carboxylic-acid ester system, a biphenyl system, a terphenyl system, a phenylcyclohexane acid system, a pyrimidine system, a pyridine system, a dioxane system, a cyclohexane cyclohexane ester system, a tolan system, an alkenyl system, a fluoro system, cyano **, and a naphthalene system.

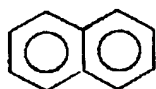
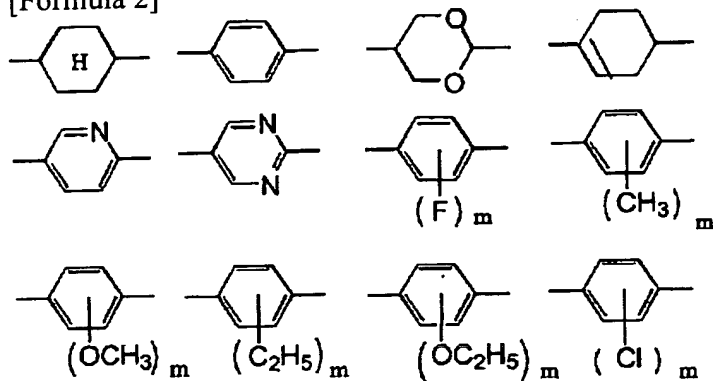
[Formula 1]



[0054] (Independently, the inside of a formula and Rings A, B, and C express one which is shown in

** 2 of rings, and are [0055], respectively.)

[Formula 2]



[0056] The integer of 0-2 and m n the integer of 1-4, and Y1 and Y2 Independently, respectively Single bond, -CH₂CH₂-, -CH₂O-, -COO-, OCO-, -C**C-, -CH=CH-, -CF=CF-, -(-CH₂)₄-, -CH₂CH₂CH₂O-, or -CH₂=CHCH₂- is expressed. - Y3 expressing single bond, -COO-, or -OCO-, R expresses a hydrogen atom, a halogen atom, a cyano group, the alkyl group of the carbon atomic numbers 1-20, an alkoxy group, an alkenyl radical, an alkenyloxy radical, a fluoro alkyl group, and a fluoro alkoxy group in independent. The liquid crystal compound expressed can be used. It is desirable to use the liquid crystal ingredient which especially contains tolan system liquid crystal and cyano liquid crystal especially.

[0057] (B) polymerization nature compound used by this invention For example, ethyl (meta) acrylate, Butyl (meta) acrylate, 2-ethylhexyl (meta) acrylate, Iso octyl (meta) acrylate, lauryl (meta) acrylate, Stearyl (meta) acrylate, iso millimeter still (meta) acrylate, Isostearyl (meta) acrylate, methoxy ethyl (meta) acrylate, ethoxyethyl (meta) acrylate, methyl carbitol (meta) acrylate, ethyl carbitol (meta) acrylate, cyclohexyl (meta) acrylate, [0058] Isoboronyl (meta) acrylate, 2-hydroxyethyl (meta) acrylate, Phenoxy (meta) acrylate, methoxy dipropylene glycol (meta) acrylate, Trifluoroethyl (meta) acrylate, dimethylamino (meta) acrylate, Morpholino ethyl (meta) acrylate, ** RUFURUORO alkyl (meta) acrylate, Polyethylene GURIKORUJI (meta) acrylate, polypropylene GURIKORUJI (meta) acrylate, Polybutylene GURIKORUJI (meta) acrylate, aliphatic series di (meth)acrylate, the epichlorohydrin denaturation 1, 6-hexane JIORUJI (meta) acrylate, JISHIKUROPENTENIRUJI (meta) acrylate, bisphenol A di(meth)acrylate, [0059] Epichlorohydrin denaturation bisphenol A di(meth)acrylate, Ethyleneoxide denaturation bisphenol A di(meth)acrylate, Propylene oxide denaturation bisphenol A di(meth)acrylate, Butylene oxide denaturation bisphenol A di(meth)acrylate, 3 and 3-dimethylol pen TANJI (meta) acrylate, 3, and 3-dimethylol HEPUTANJI (meta) acrylate, Caprolactone denaturation dipentaerythritol hexa (meta) acrylate, Acrylic ester monomer like pen TAERISURITORUTORI (meta) acrylate, pentaerythritol tetrapod (meta) acrylate, dipentaerythritol tetrapod (meta) acrylate, and dipentaerythritol hexa (meta) acrylate;

[0060] The acrylamide compound like N,N-dimethylacrylamide and N,N-dimethylaminopropyl acrylamide, Urethane (meta) acrylate, polyester (meta) acrylate, Epoxy (meta) acrylate, oligoester acrylate, hydronalium KISHIBI valine acid ester neopentyl GURIKORUJI (meta) acrylate, Caprolactone denaturation hydronalium KISHIBI valine acid ester neopentyl GURIKORUJI (meta) acrylate, TORIMECHI roll pro pantry (meta) acrylate, ethyleneoxide denaturation trimethylol propane TOTORI (meta) acrylate, Propylene oxide denaturation TORIMECHI roll pro pantry (meta) acrylate, fluorination ARUKIRUJI (meta) acrylate, the acrylate that has the alkyl group of carbon numbers 5-25 in a side chain (meta) are mentioned, and it is [0061]. As a maleimide compound, the compound with which the maleimide radical was combined by the aliphatic series radical is desirable. Furthermore, specifically N - KISHIRU maleimide, N, N' - Alkyl or alkyl ether maleimide like 4, 9-dioxa -1, and 12-bismaleimide dodecane, An ethylene glycol screw (maleimide acetate), the

Pori (tetramethylene glycol) screw (maleimide acetate), Maleimide carboxylic-acid (Pori) alkylene glycol ester, such as a tetrapod (ethylene glycol denaturation) pentaerythritol tetrapod (maleimide acetate), Although urethane maleimide, such as carbonate maleimide, such as bis(2-maleimide ethyl) carbonate, and an isophorone screw urethane screw (N-ethyl maleimide), etc. is mentioned, it is not limited to especially these.

[0062] The acrylate which has the alkyl group of carbon numbers 5-25 in a side chain among (B) polymerization nature compounds used by this invention (meta) is used especially preferably. Here, the principal chain structure of the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) is not limited especially that what is necessary is just the structure where it is used as usual acrylate. Moreover, one is sufficient as the number of side chain radicals to acrylate 1 molecule which has the alkyl group of carbon numbers 5-25 in a side chain (meta), and it may be plural.

[0063] Although especially the number is not limited, when the number of the functional groups in one molecule of the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) makes quickly the rate of polymerization of a liquid crystal ingredient, a polymerization nature compound, and the polymerization nature constituent that consists of a photopolymerization initiator what is necessary just be two or more, the optical element after manufacture should just choose the appearance which can acquire a good property, and timely that what is necessary is just to make [many] the number of functional groups.

[0064] (B) In the range which does not spoil the effectiveness of this invention, the polymerization nature compound containing the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) may use together other polymerization nature compounds, for example, di(meth) acrylate, and can also contain the monofunctional (meta) acrylate of well-known common use further. Although the polymerization nature compound (B) containing the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) may be a uniform solution and may be uneven, the thing used as a uniform solution is desirable. Moreover, it is possible to mix with a liquid crystal compound in the state of un-hardening, and, as for the polymerization nature constituent mixed with the liquid crystal compound, what becomes a homogeneity solution is desirable.

[0065] As a (C) photopolymerization initiator used by this invention For example, 2-hydroxy - 2-methyl-1-phenyl propane-1-ON ("DAROKYUA 1173" by Merck Co.), 1-hydroxy cyclohexyl phenyl ketone (the "IRUGA cure 184" by Ciba-Geigy), 1-(4-isopropyl phenyl)-2-hydroxy-isobutane-1-ON ("DAROKYUA 1116" by Merck Co.), Benzyl dimethyl ketal (the "IRUGA cure 651" by Ciba-Geigy), the 2-methyl-1-[4-(methylthio) phenyl]-2-morpholino propanone -1 (the "IRUGA cure 907" by Ciba-Geigy), [0066] The mixture of 2 and 4-diethyl thioxan ton (the "kaya cure DETX" by Nippon Kayaku Co., Ltd.) and p-dimethylamino ethyl benzoate (the "kaya cure EPA" by Nippon Kayaku Co., Ltd.), the mixture of an isopropyl thioxan ton ("can TAKYUA ITX" by the WORD PUREKIN soup company) and p-dimethylamino ethyl benzoate, etc. are mentioned.

[0067] As for the operating rate of (A) liquid crystal ingredient in a polymerization nature constituent, when it increases, it shows the inclination for driver voltage to fall, but if the rate of a liquid crystal ingredient increases too much, the rate of polymerization of a polymerization nature compound will become slow, and multilayer structure with a liquid crystal ingredient and a polymerization nature compound will become is hard to be formed. therefore, the class and rate of a liquid crystal ingredient, a polymerization nature compound, and a photopolymerization initiator are chosen the appearance to which the class of a liquid crystal ingredient, a polymerization nature compound, and photopolymerization initiator and the property of the optical element after the manufacture which boils comparatively and is depended become good, and timely.

[0068] The light of the ultraviolet-rays field used in this invention means the light of the wavelength region whose wavelength is 50-400nm. Especially as the light source of the light of an ultraviolet-rays field, although not restricted, formation of an interference fringe is possible and a coherent light is [that what is necessary is just to be able to carry out the polymerization of the polymerization nature constituent] spatially [in time and] desirable. Especially, wavelength stability and since high power, laser light is more desirable.

[0069] As a class of laser used, an argon laser, krypton laser, a helium cadmium laser, etc. are

mentioned, and the high order higher harmonic of the laser or further others may be used. The exposure reinforcement and the exposure of light are influenced by the reactivity of the polymerization nature compound to be used and the class of photopolymerization initiator, and concentration. Therefore, what is necessary is just to choose the exposure reinforcement optimal timely and the exposure optimal timely.

[0070]

[Example] The example of this invention is shown below and this invention is explained in detail. However, this invention is not limited to these examples from the first. Moreover, in the following examples, especially, as long as there is no notice, "% of the weight" is expressed and each of an evaluation property means the following notations and contents "%."

[0071] Ultraviolet-rays reinforcement is the USHIO, INC. make. It measured using uni-meter "UIT-101" and a photo detector "UVD-365PD." Using the spectrometer U-3500 (Hitachi, Ltd. make), measurement of a reflection factor measured the permeability of a sample and made reduction of the permeability by reflection the reflection factor.

[0072] ROFF: Applied voltage (V_{rms}), λ from which the reflection factor when making reflection factor (%) V_{r90} :ROFF at the time of no electrical-potential-difference impressing into 100%, and making a reflection factor when an electrical potential difference is impressed and reduction in a reflection factor is saturated into 0% becomes 10% : Main wavelength (nm) [0073] of the reflected light (Example 1) It is an argon laser (the wavelength of 363.8nm) about the light source for exposure. Consider as about 800 W/m² on the strength, and the incident angle to a transparency substrate is made into 45 degrees. The reinforcement of the reflected light in the polymerization nature constituent and transparency electrode interface of light after setting thickness of a transparency electrode to 105nm and penetrating a polymerization nature constituent, And when a transparency electrode and the sum total of the reinforcement of the reflected light in a transparency substrate interface were searched for by count using the simulation result of Geomatec, Inc., they were about 6.4 W/m².

[0074] Cyano liquid crystal RO571 (Dainippon Ink & Chemicals, Inc. make) 40% and polyethylene-glycol diacrylate The polymerization nature constituent which consists of "C101" (Toagosei make) 10% as NK ester A600 (new Nakamura chemistry company make) 50% and a polymerization initiator was poured in between the glass cells with a transparency electrode (about 11 micrometers of cel thickness) whose thickness is 105nm, and the whole substrate was held at about 25 degrees C.

[0075] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8nm, ultraviolet-rays about 800 W/m² on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. In addition, all the above-mentioned activities were done in the bright interior of a room. The reflection factors of this optical element were ROFF=45(%) and λ = 460 (nm), and the reflection factor in the screen was still more uniform.

[0076] 56% (Dainippon Ink & Chemicals, Inc. make) of liquid crystal ingredients which have a tolan frame, (Example 2) The number of the alkyls of 2 and a side chain radical Acrylate (Dainippon Ink & Chemicals synthetic compounds) 32% of 11 [a principal chain frame] [the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] And the polymerization nature constituent which consists of "C101" (Toagosei make) 12% as a polymerization initiator was poured in between the glass cells with a transparency electrode (about 11 micrometers of cel thickness) the same thickness of whose as an example 1 is about 105nm, and the whole substrate was held at about 25 degrees C.

[0077] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8nm, ultraviolet-rays about 800 W/m² on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. All the above-mentioned activities were done in the bright interior of a room. As a result of measuring many properties of this optical element, it was ROFF=21(%) V_{r90} =24 V_{rms} and λ = 460 (nm), and the reflection factor

in the screen was still more uniform.

[0078] (Example 1 of a comparison) It is an argon laser (the wavelength of 363.8nm) about the light source for exposure. Consider as about 800 W/m² on the strength, and the incident angle to a transparency substrate is made into 45 degrees. The reinforcement of the reflected light of the interface of the polymerization nature compound of the light after setting thickness of a transparency electrode to 20nm and penetrating a polymerization nature compound, and a transparency electrode, And when the sum total of the reinforcement of the reflected light of the interface of a transparency electrode and a transparency substrate was searched for by count using the simulation result of Geomatec, Inc., they were about 56 W/m².

[0079] The same polymerization nature constituent as an example 1 was poured in between the glass cells with a transparency electrode (about 11 micrometers of cel thickness) whose thickness is about 20nm, and the whole substrate was held at about 25 degrees C. After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8nm, ultraviolet-rays about 800 W/m² on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. All the above-mentioned activities were done in the bright interior of a room.

[0080] this optical element -- ROFF= -- 5 (%), lambda= 460 (nm), and ROFF= -- 1 (%), lambda= 400 (nm), and ROFF= -- 5 and (%) and the three reflected lights of lambda= 750 (nm) arose, and the reflection factor in the screen was still more uneven.

[0081]

[Effect of the Invention] This invention can be manufactured by impressing electric field in the usual bright interior of a room where a reflective degree and reflective existence can be controlled reversibly, and the light exists, and a reflection factor is high, and the optical element with a uniform reflection factor and its manufacture approach in the screen can be offered.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the mimetic diagram of the sectional view of the optical element of the reflective mold of this invention.

[Drawing 2] It is the mimetic diagram of the sectional view of the optical element of the transparency mold of this invention.

[Drawing 3] It is the mimetic diagram showing an example of the optical exposure approach in manufacture of the optical element of the reflective mold of this invention.

[Drawing 4] It is the enlarged drawing of 9 transparency cel of drawing 3 , and is the mimetic diagram showing the optical path of light when the reinforcement of the reflected light in the polymerization nature constituent and transparency inter-electrode interface of light after penetrating a polymerization nature constituent, and the reflected light in a transparency electrode and the interface between transparency substrates is low.

[Drawing 5] It is the enlarged drawing of 9 transparency cel of drawing 3 , and is the mimetic diagram showing the optical path of light when the reinforcement of the reflected light in the polymerization nature constituent and transparency inter-electrode interface of light after penetrating a polymerization nature constituent, and the reflected light in a transparency electrode and the interface between transparency substrates is high.

[Description of Notations]

1: Transparency substrate

2: Transparency electrode

3: A layer with many contents of a liquid crystal ingredient

4: A layer with many contents of a polymerization hardened material

5: Ar laser

6: Beam expander

7: Beam splitter

8: Mirror

9: Transparency cel

10: Prism

11: The polymerization nature constituent which consists of a liquid crystal ingredient and a polymerization nature compound

Incidence laser light which penetrated 12, 13:10 prism, 1 transparency substrate, and 2 transparency electrodes

14: Interference fringe

Laser light penetrated through 15, 16:2 transparency electrodes, 1 transparency substrate, and ten prism

17 18: Laser light which reflects with a transparency electrode or a transparency substrate and carries out incidence to the polymerization nature constituent of 11 again

[Translation done.]

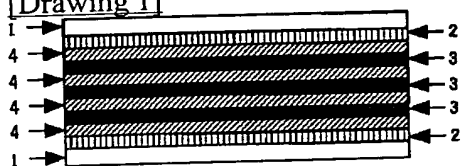
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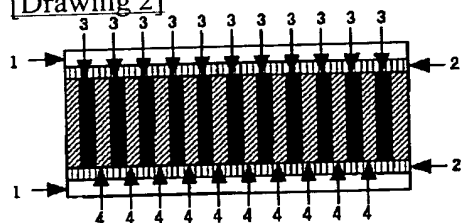
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DRAWINGS

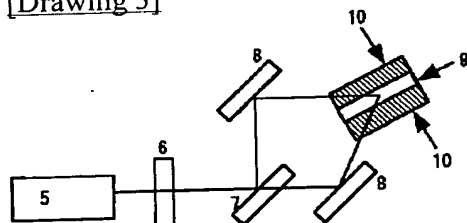
[Drawing 1]



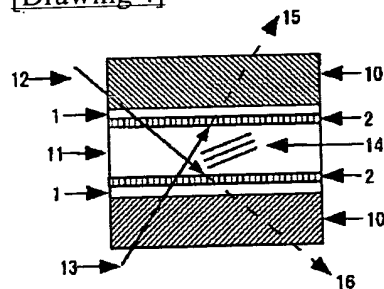
[Drawing 2]



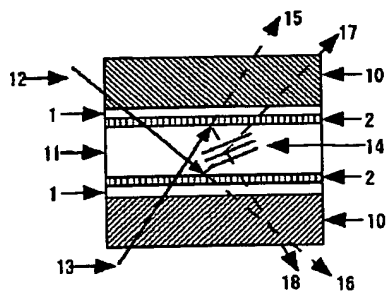
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]